William T. O'Connor, Jr.
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DTE Energy

10 CFR 50.73

October 27, 2004
NRC-04-0082

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington D C 20555-0001

Reference: Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

Subject: Licensee Event Report No. 2004-002, "Automatic Reactor Shutdown Due to Automatic Voltage Regulator Failure"

Pursuant to 10 CFR 50.73(a)(2)(iv)(A), Detroit Edison is hereby submitting the enclosed Licensee Event Report (LER) No. 2004-002. This LER documents a September 3, 2004 event where a failure of the generator exciter automatic voltage regulator (AVR) resulted in a main generator trip with subsequent main turbine trip and automatic reactor shutdown.

No commitments are being made in this LER.

Should you have any questions or require additional information, please contact Mr. Norman K. Peterson of my staff at (734) 586-4258.

Sincerely,

William T. O'Connor Jr.

cc: D. P. Beaulieu
E. R. Duncan
NRC Resident Office
Regional Administrator, Region III
Supervisor, Electric Operators,
Michigan Public Service Commission

IE22

NRC FORM 366 (6-2004) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: No. 3150-0104 Expires 6/30/2007

Estimated burden per response to comply with this mandatory collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to Infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Fermi 2	05000341	1 OF 4

4. TITLE
Automatic Reactor Shutdown Due To Automatic Voltage Regulator Failure

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
09	03	2004	2004	- 002	- 00	10	27	2004	FACILITY NAME	DOCKET NUMBER 05000
										05000

9. OPERATING MODE
1

10. POWER LEVEL
100%

11. THIS REPORT SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: *(Check all that apply)*

☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☒ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
☐ 20.2203(a)(2)(vi)	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THS LER

FACILITY NAME	TELEPHONE NUMBER (Include Area Code)
Robert J. Salmon – Principal Licensing Engineer	(734) 586-4273

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
B	TL	RG	A500	Y					

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)*

On September 3, 2004, at 2345 hours EDT, the reactor scrammed from 100% power as a result of the actuation of an Automatic Voltage Regulator (AVR) trip relay. The AVR experienced an interruption of the communications link between the digital AVR and the power converter thyristors of the generator exciter. The AVR trip resulted in a main generator trip with subsequent main turbine trip and reactor scram. The reactor protection system (RPS) performed as expected, and all rods were fully inserted into the core. Reactor water level reached a low of 137 inches above top of active fuel and recovered to normal automatically without operator intervention. Subsequent to the event, the main steam isolation valves (MSIVs) remained open and reactor water level was maintained in the normal band of 173 to 214 inches. Reactor water was supplied by the condensate and reactor feedwater systems, and the resultant reactor steam was sent to the condenser via the turbine bypass lines. Pressure control was maintained by the turbine bypass valves. Reactor dome pressure peaked at about 1090 psig. With reactor pressure maintained below the Safety Relief Valve (SRV) setpoints, none of the SRVs lifted. Reactor water Level 3 isolations occurred as expected. These included isolation Group 4 (Residual Heat Removal Shutdown Cooling and Head Spray), Group 13 (Drywell Sumps), and Group 15 (Traversing In-core Probe System) isolations.

Failed AVR components were repaired or replaced, and the plant was restarted on September 5, 2004.

17. NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)*

Initial Plant Conditions:

Mode 1
Reactor Power 100 percent

Description of the Event

On September 3, 2004, at 2345 hours EDT, the reactor scrammed from 100% power as a result of the actuation of an Automatic Voltage Regulator (AVR) [RG] trip relay. The AVR experienced an interruption of the communications link between the digital AVR and the power converter thyristors of the generator exciter [TL]. The AVR trip resulted in a main generator [TB] trip and subsequent main turbine [TA] trip. A reactor scram occurred as designed when the turbine stop valves closed more than 10% in response to the turbine trip. The reactor protection system (RPS) [JD] performed as expected, and all rods were fully inserted into the core. Reactor water level reached a low of 137 inches above top of active fuel and recovered to normal automatically without operator intervention. Subsequent to the event, the main steam isolation valves (MSIVs) remained open and reactor water level was maintained in the normal band of 173 to 214 inches. Reactor water was supplied by the condensate [SD] and reactor feedwater systems [SJ], and the resultant reactor steam was sent to the condenser [SG] via the turbine bypass lines. Pressure control was maintained by the turbine bypass valves. Reactor dome pressure peaked at about 1090 psig. With reactor pressure maintained below the Safety Relief Valve (SRV) setpoints, none of the SRVs lifted. Reactor water Level 3 isolations [JM] occurred as expected. These included isolation Group 4 (Residual Heat Removal Shutdown Cooling and Head Spray), Group 13 (Drywell Sumps), and Group 15 (Traversing In-core Probe System) isolations.

A 4-hour notification of this event was made to the NRC in accordance with 10 CFR 50.72(b)(2)(iv) at 0205 hours EDT on September 4, 2004 (EN 41017).

The AVR is part of the main generator excitation system that maintains generator output voltage under varying conditions of load within set tolerances. This is achieved by using a closed loop static excitation system consisting of a 5200 KVA excitation transformer, a rectifier cubicle (power converter thyristor unit), an excitation control cubicle (AVR unit), and a field suppression cubicle. The static excitation system controls the main generator output voltage and reactive power flow by direct variation of the generator excitation current in response to feedback signals from the generator output terminals. Excitation power is obtained from the generator output and fed through the excitation transformer to the rectifier cubicle. The rectifier cubicle supplies excitation to the main generator field through the direct current (DC) field breaker in the field suppression cubicle.

The controls for the static excitation system consist of two electronic processing units located in the excitation control cubicle and microprocessor based thyristor triggering units, located in each of three forced air cooled thyristor converter bridges (rectifier cubicles). Each processing unit contains the software for generator output voltage control (AVR), generator field current (manual voltage regulator), excitation system monitoring and protective functions, and a programmable logic controller, providing a dual channel design for complete processing redundancy. An integral part of the AVR configuration is a local area network (LAN), which communicates between the display panel and modules in both voltage regulator racks, the rectifier converter electronic control modules and the Field Breaker/Suppression Circuits. The LAN network is configured with

coaxial cabling connections between each interface/termination point and operates using an 'Arcnet' signal token passing communication system. The excitation system can provide full rated excitation with only two of the three converter thyristor bridges in service. This allows for continuous service if one bridge fails during normal operation.

Under normal conditions, the excitation control starts up with one channel selected in AVR mode. If a failure occurs in the operating channel, a transfer to the remaining AVR channel occurs automatically. If the second AVR channel fails, a transfer to the manual regulator occurs automatically.

AVR Channel 1 was not operating at the time of the event due to an earlier fault that was identified at 0541 hours on September 3, 2004, however, it was determined that AVR Channel 2 was working properly and was in control of the generator exciter prior to this event.

An investigation of the unit trip was initiated immediately after the event. Vendor personnel were involved in the troubleshooting activities. A fault tree analysis was performed to ensure that all possible causes were investigated during the troubleshooting activities. Computer diagnostic tools indicated that the AVR Channel 2 was functional, but indicated that there had been a loss of Arcnet data communication.

Failed AVR components were repaired or replaced, and the plant was restarted on September 5, 2004.

Cause of the Event

The apparent cause of the event was that an AVR trip occurred due to a failure of the Arcnet communication system. A fault tree analysis was performed, and all possible failure mechanisms have been listed and reviewed. Based on the prevailing evidence the failure is considered attributable to a failure of the Arcnet coupler/line driver type HYC 9088 or the Arcnet controller (Type COM 20020) associated erasable programmable read only memory (EPROM). All of these component chips are installed on the original Channel 1 processor module. The original Channel 1 processor (Type PP C322) module and the combination input/output data module (Type UA C326) have been sent to the original equipment manufacturer for a specific condition analysis/determination of the fault mechanism that caused the failure of the module(s).

Analysis of the Event

The AVR has no safety related function. The AVR, Generator, and Turbine trips functioned as designed. The reactor scrammed as designed when the turbine stop valves closed more than 10% in response to the turbine trip. The plant response to the turbine trip was as expected and was enveloped by the more severe turbine trip without bypass transient described in the UFSAR. There was no challenge to the integrity of the reactor coolant system or the main steam system. The lowest reactor water level during the transient was measured to be 137 inches above top of active fuel which is below the reactor water Level 3 isolation trip setpoint. Reactor water Level 3 isolations occurred as expected. These included isolation Group 4 (Residual Heat Removal Shutdown Cooling and Head Spray), Group 13 (Drywell Sumps), and Group 15 (Traversing In-core Probe System) isolations. The highest reactor pressure received was about 1090 psig which is below the safety relief valve setpoints; 5 each at 1135, 1145, and 1155 psig. Subsequent to the unit trip reactor pressure was adequately controlled using the main turbine bypass valves, and reactor water level was controlled using the condensate and feedwater systems.

Therefore, since the generator, turbine and reactor protection systems performed as designed, and since plant response was enveloped by the UFSAR transient analyses, there was no undue risk to the health and safety of the public as a result of this event.

Corrective Actions

The Channel 1 processor module and the Channel 1 combination input/output modules of the AVR were replaced and the processor software was reloaded into both AVR channels.

All Arcnet coaxial cables were tested and node "T" connectors were replaced.

The original Channel 1 processor (Type PP C322) module and the combination input/output data module (type UA C326) have been sent to the original equipment manufacturer for further analysis of the module failure mechanism(s).

This event has been documented in the Fermi 2 corrective action program, CARD 04-24040. Any further corrective actions will be tracked and implemented commensurate with the established processes and priorities of the program.

Additional Information

A. Failed Components:

Component: Processor Module
Function: Arcnet communication system
Manufacturer: ABB Brown Boveri
Model Number: PP C322
Failure Cause: Arcnet coupler/line driver or Arcnet controller failure

B. Previous LERs on Similar Problems:

There have been no previous occurrences of solid state exciter failures due to a failure of an AVR at Fermi 2.